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Initial growth response of shallot on *Trichoderma* formulated in oyster mushroom cultivation waste

Sutarman^{1,*}, AE Prihatiningrum¹, A Sukarno², A Miftahurrohmat¹

¹Program Studi Agroteknologi, Universitas Muhammadiyah Sidoarjo, Jl. Raya Candi no. 250, Sidoarjo, Jawa Timur, Indonesia

²Program Studi Konservasi Sumberdaya Hutan, Institut Pertanian Malang, Jl. Raya Soekarno-Hata no. 250, Malang, Jawa Timur, Indonesia

*E-mail: sutarman@umsida.ac.id

Abstract. This study aim was investigated the initial growth response of shallot against the activity of some *Trichoderma* isolates that were formulated in the form of oyster mushroom waste. This greenhouse experiment was prepared in a complete randomized design with the following treatments: without oyster mushroom cultivation waste, oyster mushroom cultivation waste without *Trichoderma*, oyster mushroom cultivation waste with *Trichoderma* isolate Tc-JJr-02, oyster mushroom cultivation waste with *Trichoderma* isolate Tc-Pjn-01, and oyster mushroom cultivation wastes with *Trichoderma* isolates Tc-Clkt-02. All treatments were repeated four times to obtain 20 experimental units. The variables observed were plant height length and number of leaves. Data obtained were analyzed statistically by an analysis of variance (minitab Release 14 software) and HSD test were used to indicate the significant differences between the mean values ($p < 0.05$). The results showed that *Trichoderma* was formulated in oyster mushroom cultivation wastes increased the height and the number of leaves on the initial growth of shallot crops.

1. Introduction

Oyster mushroom cultivation is beneficial not only to produce human foodstuffs [1], but also reduces agricultural waste which is a fungal substrate of the *Pleurotus* genus [2] and prevents air pollution from burning waste [3]. However, oyster mushroom cultivation waste still contains dust or wood particles that cause toxicity, allergies, and human health disorders [4] and can be a hide place for insect pests, rodents, and potential pathogenic fungal inoculums [5, 6]. On the other hand the utilization of media waste grows oyster mushrooms is not optimal; mostly used for landfilling [7, 8].

Agricultural waste contains many ligno-cellulose [9], as well as in the oyster mushroom cultivation wastes. Even some of the organic mushrooms growing media ingredients are converted into fungus body parts. All materials in the waste can be substrate for saprophytic fungi and fungi commonly used as biocontrol agents. *T. harzianum* produces chitinase enzyme (Ec 3.2.1.14) [10] which can degrade the chitin compound which is a typical molecule of fungi cell wall compounds in addition to the enzyme β -1,3-glucanase, cellulase, and peroxidase [11, 12, 13]. *Trichoderma* will use most organic materials including oyster mushroom propagules as substrates for its activity as indicated by various studies utilizing agricultural waste [14, 15, 16, 17].

Despite known as a biocontrol agent and *Trichoderma* also improves plant resistance to pathogens [18, 19, 20, 21], is also used as a biofertilizer for decomposing organic matter and



providing nutrients for plants [22, 23]. Therefore *Trichoderma* has potential to be utilized as biofertilizer for various dry land plants including onion which is one of strategic horticulture plants in Indonesia.

The application of oyster mushroom cultivation waste containing various fungi propagules [6], including those that are pathogenic and resistant to sterilization treatments, will risk the emergence of disease in the vulnerable phase of the plant that is at the beginning of plant growth. Therefore, it is necessary to evaluate the effect of *Trichoderma* application as biofertilizer which is formulated on oyster mushroom cultivation waste on vegetative growth of early onion indicating nutrient adequacy and plant safety from disease disorder. Meanwhile, the application of residual organic matter and inoculation of *T. harzianum* in addition to reducing the incidence of disease 30.3% and increasing the yield of 4.2% in canola plants [17] also increased the length of plants and fresh weight respectively by 9% and 5.3% in cucumber plants [24].

This study aim was to determine the initial growth response of shallot to the activity of some *Trichoderma* isolates that were formulated inside organic fertilizer waste of oyster mushroom cultivation.

2. Experimental Method

The oyster mushroom cultivation waste (OMCW) obtained from oyster mushroom cultivation in Sidoarjo was sterilized in autoclave at 1 atm pressure at 121°C for 30 minutes to kill all microbes. Simultaneously grown in PDA-m media [25] three kinds of *Trichoderma* isolates were: *T. harzianum* Tc-Jjr-02, *Trichoderma* sp. Tc-Pjn-01, and *Trichoderrma* sp. Tc-Clkt-02 Simultaneously grown in PDA-m media [25] three kinds of *Trichoderma* isolates are: *T. harzianum* Tc-Jjr-02, *Trichoderma* sp. Tc-Pjn-01, and *Trichoderrma* sp. Tc-Clkt-02 was isolated from agroforestry field in Mojokerto (East Java) which is a collection of Microbiology laboratory of Universitas Muhammadiyah Sidoarjo. After 10 days, each culture was harvested and simultaneously with the medium smoothed to homogeneous mixture. Further calculated the amount of active konidiosposra contained in the culture suspension. In the conidiospora content of 10^8 cfu/ml, the suspension was mixed into a container containing sterile OMCW. Water needs to be added for mixing evenly, but the conidiospora content in OMCW biological fertilizer was relatively unchanged and becomes 10^8 cfu/g.

The soil of planting media taken from Purwojati village, Ngoro district, Mojokerto regency (East Java) is a type of latosol with an average pH of 4.8. After sterilization in the autoclave is placed into a polybag capacity of 5 kg. Furthermore *Trichoderma* biological fertilizer as much as 150 g placed at the top of polybags together with the basic fertilizer NPK 5 g per polybag. The types of biological fertilizers were given according to the treatment, so that also obtained polybags given OMCW fertilizer without *Trichoderma* and which were not given OMCW fertilizer and not given *Trichoderma* isolate. Overall, polybags obtained by treatment include: without OMCW, OMCW-without *Trichoderma*, OMCW-*Trichoderma* 1 (isolate Tc-Jjr-0), OMCW-*Trichoderma* 2 (isolate Tc-Pjn-01), and OMCW -*Trichoderma* 3 isolate Tc-Clkt-02). Each treatment was repeated four times, resulting in 20 experimental units. Each unit contains six experimental plants. The test unit is placed in Group Random Design.

The variables that observed in this experiment were plant height (cm) and leaves number at 10 and 20 days after planting (ADP). Data were analyzed with Analysis of variance with level 1 significance ($\alpha= 5\%$) (minitab Release 14 software) to know the effect of treatments followed by 5% HSD test to know the difference between treatments.

3. Results and Discussion

Trichoderma biophertilizer which was formulated in oyster mushroom waste has a significant effect on the shallot response in the form of early growth of plant height and number of leaves. The mean of length of the plant and the number of leaves are listed in table 1 and table 2, respectively.

Table 1. The mean of plant height in response to the application of *Trichoderma* biological fertilizer formulated in oyster mushroom cultivation waste at 10-20 days after planting (ADP)

Treatment	10 ADP (cm)	20 ADP (cm)
without oyster mushroom cultivation waste (OMCW)	11,25 a	20,81 A
OMCW without <i>Trichoderma</i>	21,86 bc	26,15 Bc
OMCW with <i>Trichoderma</i> isolate Tc-JJr-02	18,65 b	24,26 b
OMCW with <i>Trichoderma</i> isolate Tc-Pjn-01	20,36 bc	23,72 b
OMCW with <i>Trichoderma</i> isolate Tc-Clkt-02	21,06 c	27,63 c
HSD 5%	1,90	2,57

Means followed by the same letter in the same row are not significantly different at $p < 0.05$.

Table 2. The mean of shallot leaves number as a response to the application of *Trichoderma* biological fertilizer formulated in oyster mushroom cultivation waste at 10-20ADP

Treatment	10 ADP	20 ADP
without OMCW	16,74 a	23,77 a
OMCW without <i>Trichoderma</i>	28,00 c	30,50 d
OMCW with <i>Trichoderma</i> isolate Tc-JJr-02	26,83 c	28,33 bc
OMCW with <i>Trichoderma</i> isolate Tc-Pjn-01	24,64 b	26,90 ab
OMCW with <i>Trichoderma</i> isolate Tc-Clkt-02	26,58 bc	29,67 cd
HSD 5%	2,02	3,29

Means followed by the same letter in the same row are not significantly different at $p < 0.05$.

The initial growth of the plant as indicated by the height and number of leaves in the treatment utilizing the odor of oyster mushroom waste and *Trichoderma* formulated in OMCW was higher than without oyster mushroom waste. Oyster mushrooms use ligno-cellulose in wood powder and make it a source of energy and at the same time from the macromolecule degradation process will produce low molecular weight compounds and various minerals [9, 26, 27] that are useful as nutrients for plants. The organic matter still contained in OMCW includes the ligno-cellulose compounds as is commonly in agricultural wastes to be substrate for *Trichoderma* for its growth as well as producing nutrients for plants [28, 29, 13]. In the treatment without OMCW it appears high onion plant only reached 20.81 cm and the number of leaves reached 23.77, whereas in the treatment of waste containing 10^8 *Trichoderma* spores per g reached 23.72-27.63 cm and 26.90-29,67 on

20 DAP. In line with the results of this study, the administration of 5% organic material on planting medium and *Trichoderma* with 6×10^8 spores per m^2 was able to increase the plant height and fresh weight of cucumber plants up to 9.0% and 5.3% [24]. The absence of differences in plant growth response on waste treatment not given *Trichoderma* and given *Trichoderma* suspected to be caused by various types of amino acids resulting from the degradation of organic protein by *Trichoderma* [22] is used by these fungi for their growth. On the other hand the nutrients generated from the previous oyster mushroom activity are relatively sufficient for onion plants for initial growth.

Overall the onion plants have healthy appearance. Either plant media without waste fertilizer treatment or using waste but without *Trichoderma* treatment, there are no symptoms of disease. Sterilization of the soil kills the entire mycelium and some microbial breaks propagules. For pathogenic microbial propagules, *Trichoderma* can prevent it from germinating [30]. *Trichoderma* can also improve plant health by decreasing disease incidence by more than 30% while increasing plant growth [17].

4. Conclusion

Oyster mushroom cultivation waste and *Trichoderma* isolates Tc-JJr-02, Tc-Clkt-01, and Tc-Pjn-02 fertilizers increased plant height and leaf number on initial growth of shallot crop.

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